



# 2022 ASIS&T Webinar Series April 7, 2022

*“Applying FAIR Principles to Ontologies  
(DCMI)”*

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Association for Information Science and Technology



# Applying FAIR Principles to Ontologies

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Association for Information Science and Technology  
Webinar

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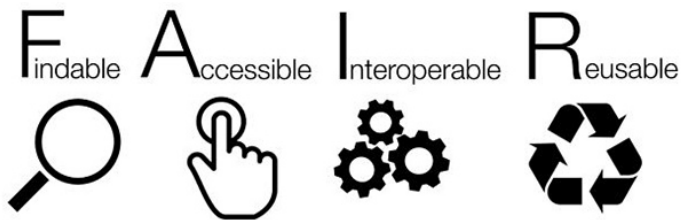
 7 April 2022

 Virtual



1. Use URIs as names for things
2. Use HTTP URIs so that people can look up those names.
3. When someone looks up a URI, provide useful information, using the standards (RDF\*, SPARQL)
4. Include links to other URIs. so that they can discover more things.

## Linked Data principles



Wilkinson, M. D. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. <https://doi.org/10.1038/sdata.2016.18> (2016)  
<https://www.nature.com/articles/sdata201618>

## Adoption:

- EOSC interoperability framework
- Research Data Alliance

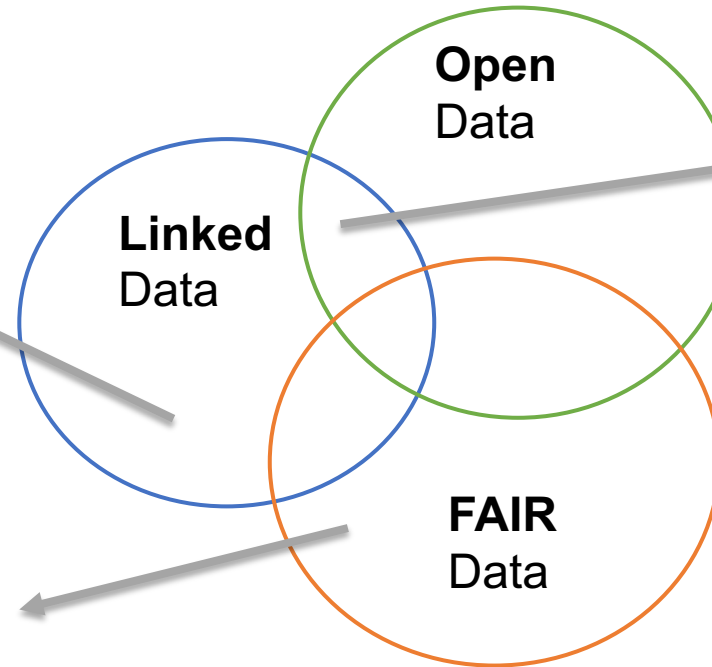


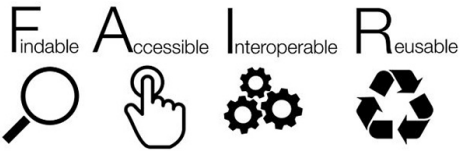
Image taken from <https://www.w3.org/DesignIssues/LinkedData.html>

- There is a clear movement towards **expanding** the application of the **FAIR** principles **beyond** research **data** [EOSC Interoperability Framework]
- **Ontologies** are often the **result** of research activities or fundamental **components** in many **research** areas
- Some initiatives (FAIRsFAIR EU Project recommendations, GO-FAIR implementation network GO-INTER, RDA Vocabulary Services Interest Group, “Best Practices for Implementing FAIR Vocabularies and Ontologies on the Web”...)

How do these works fit with the Ontology Engineering community and the Semantic Web practices?

Based on: Poveda-Villalón M., Espinoza-Arias P., Garijo D., Corcho O. (2020) Coming to Terms with FAIR Ontologies. In: Keet C.M., Dumontier M. (eds) Knowledge Engineering and Knowledge Management. EKAW 2020. Lecture Notes in Computer Science, vol 12387. Springer, Cham. [https://doi.org/10.1007/978-3-030-61244-3\\_18](https://doi.org/10.1007/978-3-030-61244-3_18)





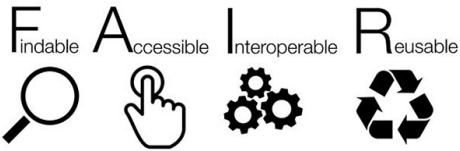
Guidelines ↓		FAIR Principles														
		F1	F2	F3	F4	A1	A1.1	A1.2	A2	I1	I2	I3	R1	R1.1	R1.2	R1.3
FAIRSFAR	P-Rec1	x														
	P-Rec2	x		x												
	P-Rec3		x										x	x	x	x
	P-Rec4				x											
	P-Rec5				x	x	x									
	P-Rec6				x											
	P-Rec7							x								
	P-Rec8								x							
	P-Rec9									x						
	P-Rec10									x	x	x				
	P-Rec11									x						
	P-Rec12									x		x				x?
	P-Rec13											?			x	x?
	P-Rec14										x					?
	P-Rec15											x			x	
	P-Rec16													x		
	P-Rec17														x	

17 recommendations, related to one or more FAIR principles related to:

- GUPRIs** (Global Unique Persistent and Resolvable Identifier)
- (minimum) **metadata** including provenance, license, etc.
- Semantic repositories**
  - API
  - Cross access
  - Secure protocols
- Use standards (languages, vocabularies)
- Mappings (between artefacts, to foundational ontologies)



Le Franc, Y., Parland-von Essen, J., Bonino, L., Lehväslaiho, et al., . D2.2 FAIR semantics: First recommendations (2020)  
<https://doi.org/10.5281/zenodo.3707985>



		FAIR Principles													
Guidelines ↓	F1	F2	F3	F4	A1	A1.1	A1.2	A2	I1	I2	I3	R1	R1.1	R1.2	R1.3
P-Rec1	x														
P-Rec2	x		x												
P-Rec3		x										x	x	x	x
P-Rec4				x											
P-Rec5				x	x	x									
P-Rec6				x											

10 guidelines for publishing FAIR **ontologies** and **vocabularies** related to:

- Accessible** and **permanent** ontology URIs
- Generation of reusable **documentation** (metadata and human oriented)
- Publication** of ontologies on the Web (formats, findable)



Garijo, Daniel, and María Poveda-Villalón. "Best Practices for Implementing FAIR Vocabularies and Ontologies on the Web." *arXiv preprint arXiv:2003.13084* (2020)

1
2
3
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9
10

“Best Practices for Implementing FAIR Vocabularies and Ontologies on the Web”

Semantic Web & Ontology Engineering

Publish your vocabulary **on the Web** at a **stable URI** with a **open** license

Provide **human-readable documentation** and basic **metadata** such as creator, publisher, date of creation, last modification, version number

Provide **labels** and **descriptions**, if possible in several languages, to make your vocabulary usable in multiple linguistic scopes

Make your vocabulary **available** via its namespace **URI**, both as a **formal** file and **human-readable** documentation, using content negotiation

**Link** to other **vocabularies** by re-using elements rather than re-inventing



Vatant, Bernard. "5-stars for vocabularies." [https://bvatant.blogspot.com/2012/02/is-your-linked-data-vocabulary-5-star\\_9588.html](https://bvatant.blogspot.com/2012/02/is-your-linked-data-vocabulary-5-star_9588.html) (2012)

There is **dereferenceable human-readable** information about the used vocabulary

The information is **available** as **machine-readable** explicit **axiomatization** of the vocabulary

The vocabulary is **linked to** other **vocabularies**

**Metadata** about the vocabulary is **available** (in a dereferencable and **machine-readable** form)

The vocabulary is **linked to by** other **vocabularies**



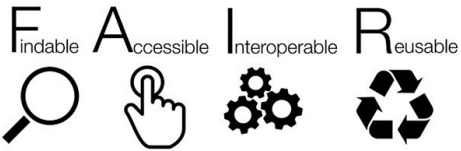
Janowicz, K., Hitzler, P., Adams, B., Kolas, D., & Vardeman, I. I. (2014). C. Five Stars of Linked Data Vocabulary Use. Semantic Web, 5-3.

Semantic V  
Ontology Eng

5-star vocabularies  
Vatant, Bernard 2012

5-star vocabularies  
SWJ 2014

	9
	10
5-stars 2012	1
	2
	3
	4
	5
5-stars 2014	1
	2
	3
	4
	5



		FAIR Principles														
Guidelines ↓		F1	F2	F3	F4	A1	A1.1	A1.2	A2	I1	I2	I3	R1	R1.1	R1.2	R1.3
FAIRSFAR	P-Rec1	x														
	P-Rec2	x		x												
	P-Rec3		x										x	x	x	x
	P-Rec4				x											
	P-Rec5				x	x	x									
	P-Rec6				x											
	P-Rec7							x								
	P-Rec8								x							
	P-Rec9									x						
	P-Rec10									x	x	x				
	P-Rec11									x						
	P-Rec12									x		x				x?
	P-Rec13											?			x	x?
	P-Rec14										x					?
	P-Rec15											x			x	
	P-Rec16													x		
	P-Rec17														x	
FAIR ontologies	1	x														
	2	x														
	3	x														
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	6		x										x	x	x	x
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	4	<				x	x			x						
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5-stars 2014	1					x										
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	3										x					
	4					x							x			
	5															

Semantic Web & Ontology Engineering

“Best Practices for Implementing FAIR Vocabularies and Ontologies on the Web”

5-star vocabularies  
Vatant, Bernard 2012

5-star vocabularies  
SWJ 2014

# Towards FAIR Ontologies – To be Findable

	Keep from SW	Needs	Discussion
F1	URIs		Persistence
F2		Minimum metadata, technical guidelines	
F3	Metadata included in the ontology		Metadata as a separate object, third-party certifier
F4	DCAT2	Federation model, SAODs	

- 🔍 F1: (meta)data are assigned a globally unique and persistent identifier
- 🔍 F2: data are described with rich metadata (defined by R1 below)
- 🔍 F3: metadata clearly and explicitly include the identifier of the data it describes
- 🔍 F4: (meta)data are registered or indexed in a searchable resource

# Towards FAIR Ontologies – To be Accessible

	Keep from SW	Needs	Discussion
F1	URIs		Persistence
F2		Minimum metadata, technical guidelines	
F3	Metadata included in the ontology		Metadata as a separate object, third-party certifier
F4	DCAT2	Federation model, SAODs	
A1, A1.1, A1.2	HTTP and HTTPS		
A2		Preservation policies	

- 👉 A1: (meta)data are retrievable by their identifier using a standardized communications protocol
- 👉 A1.1: the protocol is open, free, and universally implementable
- 👉 A1.2: the protocol allows for an authentication and authorization procedure, where necessary
- 👉 A2: metadata are accessible, even when the data are no longer available

# Towards FAIR Ontologies – To be Interoperable

	Keep from SW	Needs	Discussion
F1	URIs		Persistence
F2		Minimum metadata, technical guidelines	
F3	Metadata included in the ontology		Metadata as a separate object, third-party certifier
F4	DCAT2	Federation model, SAODs	
A1, A1.1, A1.2	HTTP and HTTPS		
A2		Preservation policies	
I1	KR languages		
I2	Methods to reuse ontologies	Indicators	Not force to reuse FAIR vocabularies
I3	Mechanisms to reference ontologies		



I1: (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.






I2: (meta)data use vocabularies that follow FAIR principles



I3: (meta)data include qualified references to other (meta)data



# Towards FAIR Ontologies – To be Reusable

	Keep from SW	Needs	Discussion
F1	URIs		Persistence
F2		Minimum metadata, technical guidelines	
F3	Metadata included in the ontology		Metadata as a separate object, third-party certifier
F4	DCAT2	Federation model, SAODs	
A1, A1.1, A1.2	HTTP and HTTPS		
A2			
I1		<p>R1: (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation</p> <p>R1.1: (meta)data are released with a clear and accessible data usage license</p> <p>R1.2: (meta)data are associated with detailed provenance</p>	
I2			
I3			
R1		Best practices for document and communicate ontologies	
R1.1	Link to the license URI or RDF description of it		
R1.2	PROV-O		
R1.3		Community standards	

# Towards FAIR Ontologies

	Keep from SW	Needs	Discussion
F1	URIs		Persistence
F2		Minimum metadata, technical guidelines	
F3	Metadata included in the ontology		Metadata as a separate object, third-party certifier
F4	DCAT2	Federation model, SAODs	
A1, A1.1, A1.2	HTTP and HTTPS		
A2		Preservation policies	
I1	KR languages		
I2	Methods to reuse ontologies	Indicators	Not force to reuse FAIR vocabularies
I3	Mechanisms to reference ontologies		
R1		Best practices for document and communicate ontologies	
R1.1	Link to the license URI or RDF description of it		
R1.2	PROV-O		
R1.3		Community standards	

## Design accessible ontology URIs:

1. Ontology name and prefix
2. Hash or slash
3. Meaningful or opaque
4. Ontology versioning
5. Permanent URIs

### Example

1. name: SAREF extension for Smart Cities, prefix: saref4city
2. `https://w3id.org/def/saref4city#`
3. `https://w3id.org/def/saref4city#AdministrativeArea`
4. `<owl:versionInfo rdf:datatype="http://www.w3.org/2001/XMLSchema#decimal"> 1.0.0</owl:versionInfo>`
5. `https://w3id.org`

Source: Garijo, Daniel, and María Poveda-Villalón. "Best Practices for Implementing FAIR Vocabularies and Ontologies on the Web." *arXiv preprint* <https://arxiv.org/abs/2003.13084> (2020).

- Generate reusable documentation

 **Ontology metadata to describe ontologies**

Recommended

Property name	Annotation Property	Rationale
License	dcterms:license	Usage conditions
Creator	dcterms:creator	Provenance and attribution
Contributor	dcterms:contributor	Provenance and attribution
Creation date	dcterms:created	Provenance
Previous version	owl:priorVersion	Provenance and comparison
Namespace URI	vann:preferredNamespaceUri	Identifying the ontology
Version IRI	owl:versionIRI	Versioning
Prefix	vann:preferredNamespacePrefix	Identifying the ontology
Title	dcterms:title	Understanding
Description	dcterms:description	Understanding
Citation	dcterms:bibliographicCitation	Credit

Optional

Property name	Annotation Property	Rationale
Abstract	dcterms:abstract	Additional information
See also	rdfs:seeAlso	Additional information
Status	sw:status	Maturity information
Backward compatibility	owl:backwardCompatibility	Version compatibility
Incompatibility	owl:incompatibleWith	Version compatibility
Modification Date	dcterms:modified	Provenance and timeliness
Issued date	dcterms:issued	Provenance and timeliness
Source	dcterms:source	Provenance
Publisher	dcterms:published	Provenance
DOI	bibo:doi	Bibliographic information
Logo	foaf:logo	Identifying the ontology
Diagram	foaf:depiction	Visual documentation

Taken from Paola Espinoza Arias

- Generate reusable documentation
  - ♻️ Ontology metadata to describe **terms**

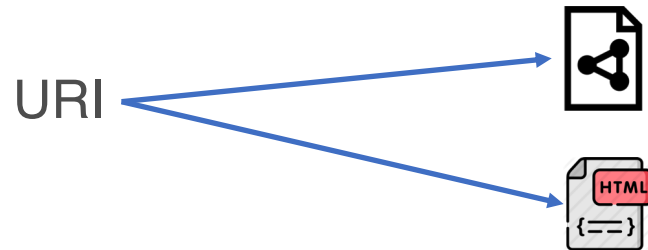
Recommended	Property name	Annotation Property	Rationale
	Label	rdfs:label	Readability
	Definition	rdfs:comment	Understanding

Optional	Property name	Annotation Property	Rationale
	Example	vann:example	Understanding
	Status	sw:term_status	Understanding
	Rationale	vaem:rational	Understanding
	Source	dcterms:source	Provenance



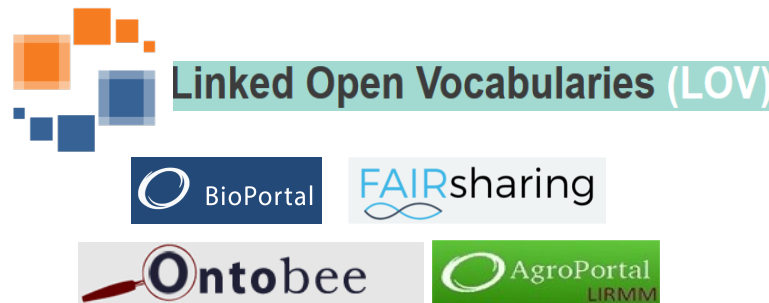
- Publish the ontology on the Web

 Provide several interoperable formats



- Own URI
- purl, w3id, etc.
- Content negotiation

 Make the ontology findable



```
<!-- Annotations for the example ontology -->
<script type="application/ld+json">{
  "@context": "http://schema.org",
  "@type": "WebPage",
  "url": "https://w3id.org/example",
  "name": "The example ontology",
  "datePublished": "4-2-2020",
  "version": "1.0.1",
  "license": "http://creativecommons.org/licenses/by/2.0/",
  "author": [{ "@type": "Person", "name": "Daniel Garijo" },
             { "@type": "Person", "name": "Maria Poveda" } ],
}</script>
```





## Data Catalog Vocabulary (dcat)

Metadata

URI	<a href="http://www.w3.org/ns/dcat">http://www.w3.org/ns/dcat</a>
Namespace	<a href="http://www.w3.org/ns/dcat#">http://www.w3.org/ns/dcat#</a>
homepage	<a href="http://www.w3.org/TR/vocab-dcat/">http://www.w3.org/TR/vocab-dcat/</a>
Description	DCAT is an RDF vocabulary designed to facilitate interoperability between data catalogs published on the Web <a href="#">@en</a>
Language	<div style="display: flex; justify-content: space-around;"> <div>Arabic ar</div> <div>Greek el</div> <div>English en</div> <div>Spanish es</div> <div>French fr</div> </div> <div style="margin-top: 5px;"> <div>Japanese ja</div> </div>
Contributor	<div style="margin-bottom: 5px;"> <div>Richard Cyganiak <a href="http://google.com/+RichardCyganiak">http://google.com/+RichardCyganiak</a></div> </div> <div style="margin-bottom: 5px;"> <div>Phil Archer <a href="https://plus.google.com/103670676337547906055">https://plus.google.com/103670676337547906055</a></div> </div> <div> <div>Fadi Maali</div> </div>

### Statistics

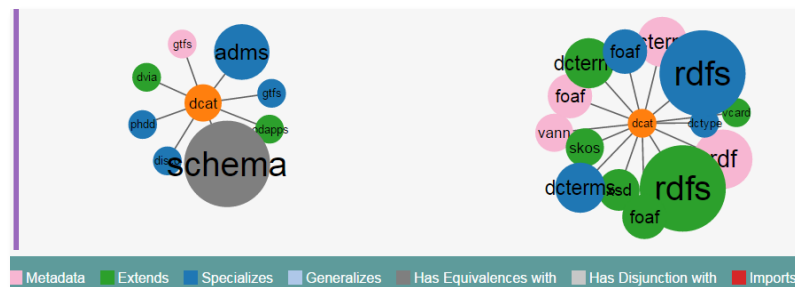
- Classes: 7
- Properties: 17
- Datatypes: 0
- Instances: 0

### Expressivity

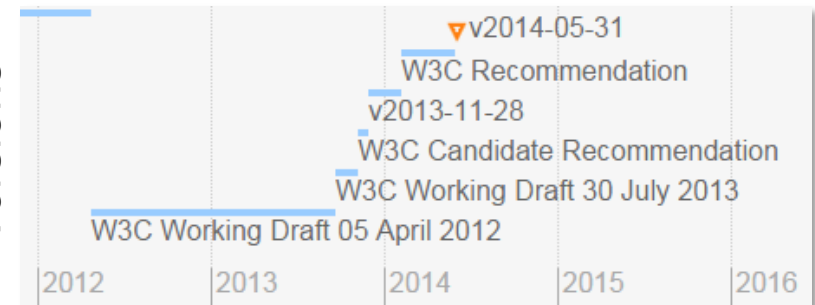
RDF
RDFS

### Tags

- W3C Rec



Versions



Taken from: <https://www.slideshare.net/MariaPovedaVillalon/linked-open-vocabularies>



## LOV SPARQL Endpoint / Data Dump

### SPARQL

#### Query Examples

```

1 PREFIX vann:<http://purl.org/vocab/vann/>
2 PREFIX voaf:<http://purl.org/vocommons/voaf#>
3
4 ### Vocabularies contained in LOV and their prefix
5 SELECT DISTINCT ?vocabPrefix ?vocabURI {
6   GRAPH <http://lov.okfn.org/dataset/lov>{
7     ?vocabURI a voaf:Vocabulary.
8     ?vocabURI vann:preferredNamespacePrefix ?vocabPrefix.
9   } ORDER BY ?vocabPrefix

```



Table Raw Response

SPARQL query

### Data Dump



n3 LOV



nq LOV + vocabs

### APIs

Consider using LOV APIs when appropriate

Dumps

### LOV API documentation

Functions defined in LOV can be called with an HTTP GET request. The response to the function you call is in JSON format. Browser plugins like [JSONView for Firefox](#) or [Chrome](#) will format and color LOV's JSON response nicely in your browser.

#### Vocabulary Term (Class, Property, Datatype, Instance)

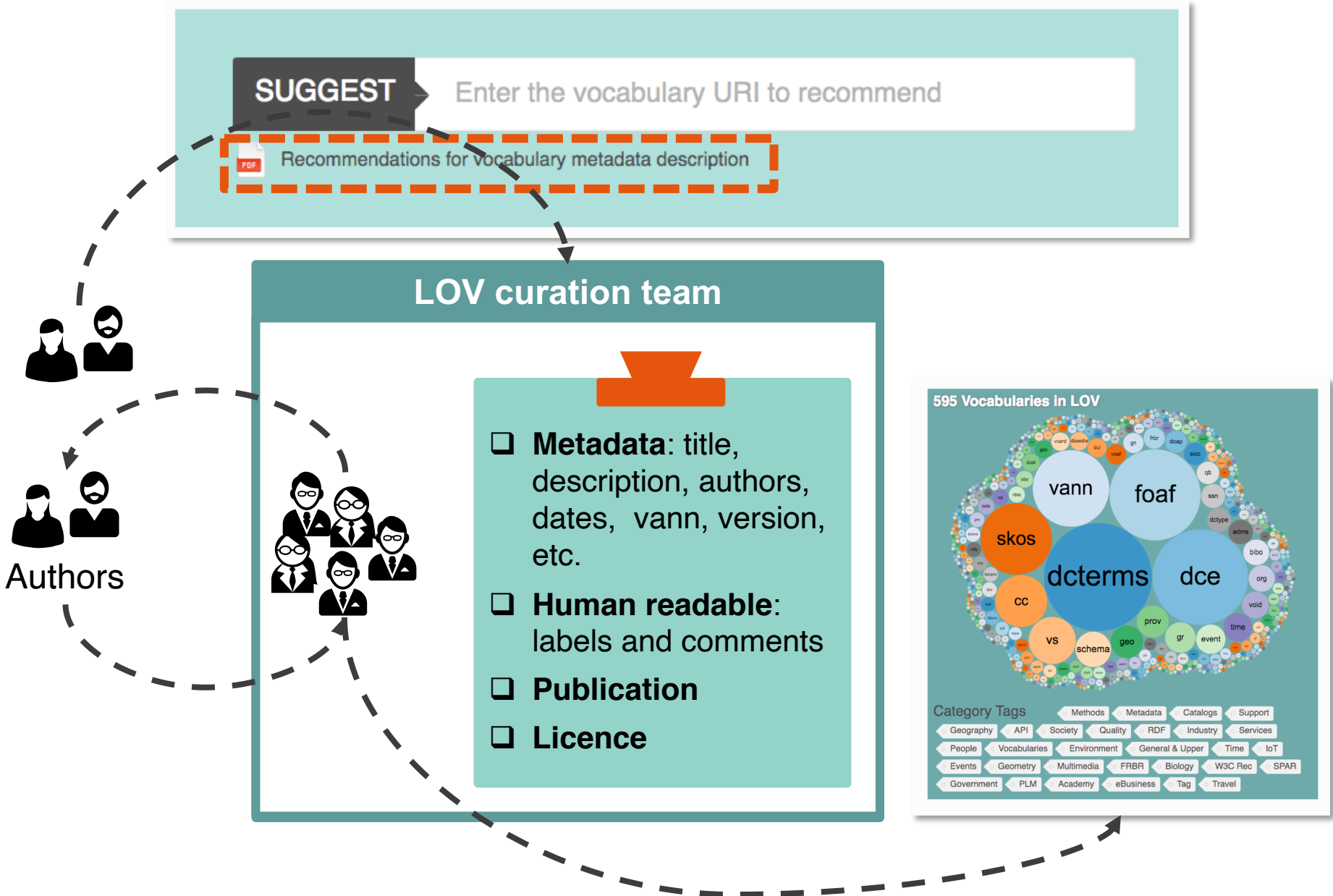
GET	/api/v2/term/search	Search Term API v2
GET	/api/v2/term/autocomplete	Autocomplete Term API v2
GET	/api/v2/term/suggest	Suggest Term API v2

#### Vocabulary

GET	/api/v2/vocabulary/list	List Vocab API v2
GET	/api/v2/vocabulary/search	Search Vocab API v2
GET	/api/v2/vocabulary/autocomplete	Autocomplete Vocab API v2
GET	/api/v2/vocabulary/info	Info Vocab API v2

#### Agent

GET	/api/v2/agent/list	List Agent API v2
GET	/api/v2/agent/search	Search Agent API v2
GET	/api/v2/agent/autocomplete	Autocomplete Agent API v2
GET	/api/v2/agent/info	Info Agent API v2



## Ontologies:

### Identification

- voaf:Vocabulary,  
vann:preferredNamespacePrefix,  
vann:preferredNamespaceUri

### Title and description:

- dcterms:title, dcterms:description

### Version and modification:

- dcterms:issued, dc:modified,  
owl:versionInfo

### Rights and property:

- dcterms:rights, cc:license,  
dcterms:creator,  
dcterms:contributor,  
dcterms:publisher

## Ontology terms:

- rdfs:label, rdfs:comment,  
rdfs:isDefinedBy, vs:term\_status



- **Validation service** inspired by OOPS!  
(Ontology Pitfall Scanner)
- Designed to **guide users**
  - Tests have an explanation
  - Tests indicate potential errors
- **Practical**
  - Based on years of ontology engineering practices at UPM
- Aligned to **FAIR**

<https://w3id.org/foops/>

Slide taken from “FOOPS! An Ontology Pitfall Scanner for the FAIR principles. Dbpedia day” by Daniel Garijo





## Foops! Ontology Pitfall Scanner for FAIR (Beta)

[Validator](#) [About](#)

URI
<input type="text" value="https://w3id.org/example"/>
Example: <a href="https://w3id.org/example">https://w3id.org/example</a> (click <a href="#">here</a> to enter this ontology)

Slide taken from “FOOPS! An Ontology Pitfall Scanner for the FAIR principles. Dbpedia day” by Daniel Garijo

<https://w3id.org/foops/>

Title:

URI:

License:

Ontology metadata summary



FAIRness coverage by category

FAIRness overall score.

**Note:** this may be a **quality indicator**, but there is no defined threshold for FAIRness.

Findable

Accessible

Interoperable

I1: (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation

RDF1: RDF Availability 100%

I2: (meta)data use vocabularies that follow FAIR principles

VOC1: Vocabulary reuse (metadata) 100%

VOC2: Vocabulary reuse 0%

Description: This check verifies if the ontology imports/extends other vocabularies (besides RDF, OWL and RDFS)

Explanation: Could not find any imported/reused vocabularies

FAIR Category

Check

Check coverage

Check description

Check explanation

Slide taken from “FOOPS! An Ontology Pitfall Scanner for the FAIR principles. Dbpedia day” by Daniel Garijo

- Metadata is one of requirements to produce FAIR ontologies.
- Need for discussion inter and across communities
  - Whether SW community should establish mechanisms and authorities to coin persistent identifiers
  - In which cases should we provide the metadata as separate objects?
- Adopt existing practices and technologies
- Do not reinvent the wheel or set overkilling requirements
  - There are systems implementing a minimum set of metadata.



# Applying FAIR Principles to Ontologies

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Universidad Politécnica de Madrid

Association for Information Science and Technology  
Webinar



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7 April 2022



Virtual



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<https://www.asist.org/meetings-events/webinars/>



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A copy of the recording and a follow-up survey will be emailed within 24 hours.

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**FABRIKAM**